TITLE OF THE INVENTION

DUST AND DIRT DETECTION IN IMAGE READING APPARATUS
HAVING ORIGINAL FLOW SCANNING FUNCTION

5 FIELD OF THE INVENTION

The present invention relates to an image reading
apparatus, dust detection method, and control method
and image processing method for an image reading
apparatus using the dust detection method and, more
10 particularly, to dust and/or dirt detection in an image
reading apparatus which reads an original while being
fed.

BACKGROUND OF THE INVENTION

15 Conventionally, there are image reading
apparatuses capable of reading an original in two
different ways, i.e., reading an original stationarily
placed on a platen glass by moving a scanner (referred
to as "stationary reading operation" hereinafter), and
20 reading an original by a scanner at a fixed position
while feeding the original along the platen glass by an
automatic document feeder (referred to as "read-while-
feed operation" hereinafter) are known. This read-
while-feed operation can shorten the reading time of
25 entire originals as compared to the stationary reading
method because original exchange and reading can be
simultaneously performed, and the image reading section

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need not be returned to the home position to read the
next original.

In the above-described read-while-feed operation,
however, since an original image is read at a fixed
position on the platen glass, black streaks may be
formed on the read image due to dust or dirt between
the platen glass and the original or on the lower
surface of the platen glass, and an original image can
not be read properly. Hence, detecting of dust and/or
dirt sticking to the platen glass (referred to as "dust
detection") is executed to prevent any abnormal image
reading due to dust and/or dirt on the platen glass.

In detecting dust and/or dirt in an image reading
apparatus, having the above arrangement, with a
function of conveying an original to be read to the
reading position using a conveyor belt, normally, the
density of the white conveyor belt is partially sampled
first to obtain the average density and determine a
threshold value. The threshold value is compared with
read data to detect dust and/or dirt. This dust
detection operation is executed a plurality of number
of times, and the number of times of detection of the
dust and/or dirt at each pixel position is counted,
thereby determining dust and/or dirt.

However, to obtain the average density of the
conveyor belt, a memory for storing sampling data is
necessary. Additionally, a line memory is also

necessary to count dust and/or dirt at each pixel. The
number of times of sampling is limited within the range
of the number of bits of the line memory. That is, for
more accurate dust detection, the memory capacity must
5   be large.

Furthermore, in the above-described dust
detection method using a conveyor belt, if the conveyor
belt surface is dirty, dirt on the original glass plate
surface cannot be normally detected.

10   As described above, the dust detection method
using image data from an image reading element depends
on dirt on the conveyor belt or convey roller surface
of the original convey section. If not the platen
glass but the conveyor belt or roller is dirty, an
15   image is read from the image reading element as if the
platen glass surface were dirty.

SUMMARY OF THE INVENTION

The present invention has been made in
20   consideration of the above situation, and has as its
object to execute accurate dust detection using a
smaller memory capacity in an image reading apparatus
capable of performing read-while-feed operation.

According to the present invention, the foregoing
25   object is attained by providing an image reading
apparatus comprising: a document feeder adapted to
convey an original; an image sensor adapted to read the

original conveyed to a platen by the document feeder; a
memory adapted to store image data for each pixel; a
controller adapted to control the image sensor to
execute reading at a predetermined position a plurality
5   of number of times without placing any original on the
platen while driving an original convey member of the
document feeder; a comparator adapted to compare image
data of the original output from the image sensor with
image data of a corresponding pixel, which is stored in
10   the memory, every time the original convey member is
read, and update the image data stored in the memory to
data having a larger value; and a detector adapted to
detect a presence/absence and position of dust and dirt
on the platen on the basis of the number of times of
15   reading the original convey member and the image data
stored in the memory after the end of a plurality of
number of times of reading the original convey member.

According to the present invention, the foregoing
object is also attained by providing an image reading
20   apparatus comprising: a document feeder adapted to
convey an original; an image sensor adapted to read the
original conveyed to a platen by the document feeder; a
controller adapted to control the image sensor to
execute reading at a predetermined position a plurality
25   of number of times without placing any original on the
platen while driving an original convey member of the
document feeder; an adder adapted to add for each pixel

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image data of the original convey member read the plurality of number of times; a memory adapted to store for each pixel the image data added by the adder; a determination unit adapted to determine a threshold value on the basis of the number of times of reading the original convey member and the image data stored in the memory; and a detector adapted to detect a presence/absence and position of dust and dirt on the platen on the basis of the threshold value and image data output from the image sensor without placing any original on the platen.

The foregoing object is also attained by providing a dust detection method in an image reading apparatus having a document feeder adapted to convey an original, an image sensor adapted to read the original conveyed to a platen by the document feeder, and a memory adapted to store image data for each pixel, comprising: controlling the image sensor to execute reading at a predetermined position a plurality of number of times without placing any original on the platen while driving an original convey member of the document feeder; comparing image data of the original output from the image sensor with image data of a corresponding pixel, which is stored in the memory, every time the original convey member is read; updating the image data stored in the memory to data having a larger value on the basis of a comparison result; and

detecting a presence/absence and position of dust and dirt on the platen on the basis of the number of times of reading the original convey member and the image data stored in the memory after the end of a plurality

5   of number of times of reading the original convey member.

Further, the foregoing object is also attained by providing a dust detection method in an image reading apparatus having a document feeder adapted to convey an

10   original, and an image sensor adapted to read the original conveyed to a platen by the document feeder, comprising: controlling the image sensor to execute reading at a predetermined position a plurality of number of times without placing any original on the

15   platen while driving an original convey member of the document feeder; adding for each pixel image data of the original convey member read the plurality of number of times; storing for each pixel the added image data in a memory; determining a threshold value on the basis

20   of the number of times of reading the original convey member and the image data stored in the memory; and detecting a presence/absence and position of dust and dirt on the platen on the basis of the threshold value and image data output from the image sensor without

25   placing any original on the platen.

According to the present invention, a plurality of white data in a non-image portion are sampled, and

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only the maximum value is held. Since no white data is read in a dust region, any threshold value need not be determined from the average density. Hence, processing can be simplified, and the memory can be omitted.

5   In addition, since the limitation on the number of times of sampling, which is determined by the bit width of the memory, can be eliminated, sampling can be executed more times. Hence, a decrease in memory capacity and accurate dust detection by eliminating the
10   limitation on the number of times of sampling can be simultaneously realized.

It is the second object of the present invention to provide a control method and image processing method for an image reading apparatus that executes the above
15   dust detection method.

According to the present invention, the foregoing second object is attained by providing a control method for the image reading apparatus which executes the foregoing dust detection method, wherein when the dust
20   or dirt is detected, a position of the image sensor is moved, and the dust detection method is repeatedly executed.

Further, according to the present invention, the foregoing second object is also attained by providing a
25   control method for the image reading apparatus which executes the foregoing dust detection method, wherein the image reading apparatus has a first reading mode in

which a position of the image sensor is fixed, and the
original is read while being conveyed by the document
feeder and a second reading mode in which the original
is stationarily held on the platen and read while

5   moving the image sensor, and the method comprises:
moving the image sensor to one of a plurality of
predetermined positions when the dust or dirt is
detected, and repeatedly executing the dust detection
method, and inhibiting the first reading mode and

10   setting the second reading mode when the dust or dirt
is detected at all of the plurality of positions.

Furthermore, the foregoing second object is also
attained by providing a control method for the image
reading apparatus which executes the foregoing dust

15   detection method, wherein when the dust or dirt is
detected, a position of the image sensor is moved, and
the dust detection method is repeatedly executed.

Further, the foregoing second object is also
attained by providing a control method for the image

20   reading apparatus which executes the foregoing dust
detection method, wherein the image reading apparatus
has a first reading mode in which a position of the
image sensor is fixed, and the original is read while
being conveyed by the document feeder and a second

25   reading mode in which the original is stationarily held
on the platen and read while moving the image sensor,
and the method comprises: moving the image sensor to

one of a plurality of predetermined positions when the dust or dirt is detected, and repeatedly executing the dust detection method, and inhibiting the first reading mode and setting the second reading mode when the dust

5   or dirt is detected at all of the plurality of positions.

Further, the foregoing second object is also attained by providing an image processing method in the image reading apparatus which executes the foregoing

10 dust detection method, comprising replacing pixel data corresponding to a position of the detected dust or dirt with pixel data of a pixel position adjacent to the position of the dust or dirt.

Further, the foregoing second object is also

15 attained by providing an image processing method in the image reading apparatus which executes the foregoing dust detection method, comprising replacing pixel data corresponding to a position of the detected dust or dirt with pixel data input for an immediately preceding

20 pixel.

Further, the foregoing second object is also attained by providing an image processing method in the image reading apparatus which executes the foregoing dust detection method, comprising replacing pixel data

25 corresponding to a position of the detected dust or dirt with pixel data of a pixel position adjacent to the position of the dust or dirt.

Further, the foregoing second object is also attained by providing an image processing method in the image reading apparatus which executes the foregoing dust detection method, comprising replacing pixel data corresponding to a position of the detected dust or dirt with pixel data input for an immediately preceding pixel.

Other features and advantages of the present invention will be apparent from the following description taken in conjunction with the accompanying drawings, in which like reference characters designate the same or similar parts throughout the figures thereof.

BRIEF DESCRIPTION OF THE DRAWINGS

The accompanying drawings, which are incorporated in and constitute a part of the specification, illustrate embodiments of the invention and, together with the description, serve to explain the principles of the invention.

Fig. 1 is a block diagram showing an arrangement of a digital copying machine according to an embodiment of the present invention;

Fig. 2 is a sectional view of the digital copying machine according to the embodiment of the present invention;

Fig. 3 is a block diagram showing control functions of the digital copying machine according to

the embodiment of the present invention;

Fig. 4 is a block diagram showing the arrangement of an image processing unit according to the embodiment of the present invention;

Fig. 5 is a block diagram showing the arrangement of an image memory section according to the embodiment of the present invention;

Fig. 6 is a block diagram showing the arrangement of an external I/F processing section according to the embodiment of the present invention;

Figs. 7A to 7D are schematic sectional views of an automatic document feeder according to the embodiment of the present invention for explaining original feeding operation;

Figs. 8A to 8D are schematic sectional views of the automatic document feeder according to the embodiment of the present invention for explaining original feeding operation;

Figs. 9A to 9C are schematic sectional views of the automatic document feeder according to the embodiment of the present invention for explaining original feeding operation;

Figs. 10A and 10B are schematic sectional views of the automatic document feeder according to the embodiment of the present invention for explaining original feeding operation;

Fig. 11 is a view showing the direction of

originals discharged from an original discharge port
according to the embodiment of the present invention;

Fig. 12 is a block diagram showing the
arrangement of a dust determination unit according to a
first embodiment of the present invention;

Fig. 13 is a flow chart showing dust
determination processing according to the first
embodiment of the present invention;

Figs. 14A and 14B are graphs showing data in a
line memory, which are obtained when a feed belt
portion corresponding to 128 lines is read and a feed
belt portion corresponding to 256 lines is read without
any dust or dirt on the platen in the first embodiment
of the present invention;

Figs. 15A and 15B are graphs showing data in the
line memory, which are obtained when a feed belt
portion corresponding to 128 lines is read and a feed
belt portion corresponding to 256 lines is read with
dust on the platen in the first embodiment of the
present invention;

Fig. 16 is a block diagram showing the
arrangement of a dust determination unit according to a
second embodiment of the present invention;

Fig. 17 is a flow chart showing dust
determination processing according to the second
embodiment of the present invention;

Figs. 18A and 18B are graphs showing data in a

line memory, which are obtained when a feed belt portion corresponding to 128 lines is read and a feed belt portion corresponding to 256 lines is read without any dust or dirt on the platen in the second embodiment

5   of the present invention;

Figs. 19A and 19B are graphs showing data in the line memory, which are obtained when a feed belt portion corresponding to 128 lines is read and a feed belt portion corresponding to 256 lines is read with

10   dust on the platen in the second embodiment of the present invention;

Fig. 20 is a block diagram showing the arrangement of a dust determination unit and image processing unit according to a modification of the

15   present invention;

Fig. 21 is a block diagram showing the arrangement of a dust determination unit and image processing unit according to the modification of the present invention;

20   Fig. 22 is a flow chart showing a procedure of image data processing according to the modification of the present invention;

Fig. 23 is a block diagram showing the arrangement of a dust determination unit according to a

25   third embodiment of the present invention;

Fig. 24 is a flow chart for explaining dust detection processing according to the third embodiment

of the present invention;

Fig. 25 is a flow chart for explaining a control method for an image reading apparatus according to the third embodiment of the present invention;

5   Fig. 26 is a flow chart for explaining the control method for the image reading apparatus according to the third embodiment of the present invention; and

Fig. 27 is a view showing alarm display on an
10   operation unit according to the third embodiment of the present invention.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Preferred embodiments of the present invention
15   will be described in detail in accordance with the accompanying drawings.

<First Embodiment>

As an image reading apparatus according to the present invention, a digital copying machine will be
20   described below.

Fig. 1 is a block diagram showing the arrangement of a digital copying machine according to the first embodiment of the present invention. A reader section 1 reads the image of an original and outputs image data
25   corresponding to the original image to an image memory section 3. A printer section 2 prints an image corresponding to the image data from the image memory

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section 3 on printing paper. The image memory section
3 compresses the image data transferred from the reader
section 1 and stores the compressed image data, or
expands the stored compressed image data and transfers
5   the expanded image data to the printer section 2. The
image memory section 3 also transfers stored image data
to an external I/F processing section 4 or stores image
data transferred from the external I/F processing
section 4.

10   The external I/F processing section 4 executes
predetermined processing for the image data transferred
from the image memory section 3 and outputs the image
data to an external device, or executes predetermined
processing for image data sent from the external device
15   and transfers the image data to the image memory
section 3. An automatic document feeder 6 is connected
to the reader section 1 to feed a placed original to a
predetermined position.

        Fig. 2 is a sectional view showing the digital
20   copying machine of the present invention. Referring to
Fig. 2, reference numeral 200 denotes a main body of a
digital copying machine 199; 6, the automatic document
feeder; 201, a platen glass serving as a platen; and
202, a scanner constituted by an original illumination
25   lamp 203, scanning mirror 204, and the like. The
scanner 202 is reciprocally moved by a motor (not
shown) to send reflected light from an original through

the scanning mirrors 204 to 206 and a lens 207, thereby forming an image on a CCD sensor in an image sensor 208.

An exposure control section 209 formed from a laser, polygon scanner, and the like irradiates an electrostatic drum 211 with a laser beam 219 that is modulated on the basis of an image signal converted into an electrical signal and has undergone predetermined image processing (to be described later) by the image sensor 208. A primary charger 212, developing unit 213, transfer charger 216, separation charger 217, pre-exposure lamp 214, and cleaning unit 215 are arranged around the electrostatic drum 211.

In an image forming unit 210, the electrostatic drum 211 is rotated by a motor (not shown) in a direction indicated by an arrow in Fig. 2. The electrostatic drum 211 is charged to a desired potential by the primary charger 212 and then irradiated with the laser beam 219 from the exposure control section 209 so that an electrostatic latent image is formed. The electrostatic latent image formed on the electrostatic drum 211 is developed by the developing unit 213 and converted into a visible toner image.

On the other hand, a transfer paper sheet fed from a right cassette deck 221, left cassette deck 222, upper cassette 223, or lower cassette 224 by a pickup roller 225, 226, 227, or 228 is fed to the main body by

feed rollers 229, 230, 231, or 232, and fed to a
transfer belt by registration rollers 233. The visible
toner image is transferred onto the transfer paper
sheet by the transfer charger 216.

5   After transfer, residual toner on the
electrostatic drum 211 is cleaned by the cleaning unit
215, and residual charges are erased by the
pre-exposure lamp 214. After transfer, the transfer
paper sheet is separated from the electrostatic drum

10   211 by the separation charger 217 and fed to a fixer
235 by a transfer belt 234. The transfer paper sheet
is pressed and heated by the fixer 235 to fix the toner
image and then discharged outside the main body 200 by
discharge rollers 236.

15   A deck 250 capable of storing, e.g., about 4,000
transfer paper sheets is arranged on the right side of
the main body 200. A lifter 251 of the deck 250 moves
upward in accordance with the amount of transfer paper
such that a transfer paper sheet always abuts against a

20   pickup roller 252. The transfer paper sheet is fed to
the main body by feed rollers 253. A multiple manual
feed tray 254 capable of storing 100 transfer paper
sheets is also arranged. Further, a discharge flapper
237 switches between a convey path 238 and a discharge

25   path 243.

Reference numeral 240 denotes a lower convey path.
A transfer paper sheet fed from the discharge rollers

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236 is turned and guided to a re-feed path 241 through an inverting path 239. A transfer paper sheet fed from the left cassette deck 222 by the feed rollers 230 is also guided to the re-feed path 241. Re-feed rollers

5   242 re-feeds a transfer paper sheet to the image forming unit 210.

Discharge rollers 244 arranged near the discharge flapper 237 discharge a transfer paper sheet passed through the discharge path 243 from the copying machine.

10   In a double-side printing (double-side copy) mode, the discharge flapper 237 is moved upward to guide a printed transfer paper sheet to the re-feed path 241 through the convey path 238, inverting path 239, and lower convey path 240. At this time, the transfer

15   paper sheet is pulled into the inverting path 239 by inverting rollers 245 until the trailing edge of the transfer paper sheet is completely removed from the convey path 238, and the transfer paper sheet engages with the inverting rollers 245. Then, the inverting

20   rollers 245 are rotated in reverse directions to send the transfer paper sheet to the lower convey path 240.

To invert and discharge a transfer paper sheet from the main body, the discharge flapper 237 is moved upward. The transfer paper sheet is pulled into the

25   inverting path 239 by the inverting rollers 245 while leaving the trailing edge of the transfer paper sheet in the convey path 238. Then, the inverting rollers

245 are rotated in reverse directions to turn the transfer paper sheet and send it to the discharge roller 244.

In a discharge processing unit 290, transfer
5 paper sheets discharged from the main body 200 of the digital copying machine one by one are stacked and aligned on a processing tray 294. When a set of paper sheets is discharged, the transfer paper sheets are stapled and discharged to a discharge tray 292 or 293.
10 The discharge tray 293 is moved upward or downward by a motor (not shown) to the processing tray position before the start of image forming operation. Partition paper sheets to be inserted between discharged transfer paper sheets are stacked on a paper tray 291. A
15 Z-folder 295 Z-folds discharged transfer paper sheets. A binder 296 folds a set of discharged transfer paper sheets at the center and stables the sheets to bind them. The bound paper sheets are discharged to a discharge tray 297.

20 Fig. 3 is a control block diagram in the digital copying machine 199. Referring to Fig. 3, a CPU 171 executes basic control of the digital copying machine 199. A ROM 174 with a control program written, a work RAM 175 used to execute processing, and an input/output
25 port 173 are connected to the CPU 171 through address and data buses. The input/output port 173 is connected to various kinds of loads (not shown) for controlling

the digital copying machine 199, such as a motor and clutch, and the input (not shown) of a sensor for detecting the paper position.

The CPU 171 sequentially controls input/output through the input/output port 173 in accordance with the contents of the ROM 174, thereby executing image forming operation. An operation unit 172 is connected to the CPU 171. The CPU 171 controls a display unit and key input unit of the operation unit 172. An operator instructs the CPU 171 to switch display between the image forming mode, the scanner reading mode, and the print output mode through the key input unit. The CPU 171 displays the state of the digital copying machine 199 and operation mode setting by key input.

The CPU 171 is connected to an image processing unit 170 for processing a signal converted into an electrical signal by the image sensor 208, the image memory section 3 for storing a processed image, and a dust determination unit 176 for detecting dust and/or dirt on the platen glass 201 from a signal digitized by the image processing unit 170.

Image processing operation will be described next with reference to Fig. 4.

Fig. 4 is a block diagram showing the arrangement for image processing. An original image formed on the CCD sensor 208 through the lens 207 is input as

luminance data of black and converted into an analog
electrical signal by the CCD sensor 208. The converted
image information is input to an analog signal
processor (not shown), subjected to sample-and-hold and
5   dark level correction, and A/D-converted by an A/D
converter 501. The digitized signal is subjected to
shading correction (variation in sensor for reading the
original and the light distribution characteristic of
the original illumination lamp are corrected).

10   After that, the signal is sent to a log converter
502. The log converter 502 stores an LUT used to
convert received luminance data into density data. The
luminance data is converted into density data by
outputting a table value corresponding to the received
15   data. The image is changed to a desired magnification
by a magnification processing unit 503 and input to a
γ-correction unit 504. In outputting the density data,
the γ-correction unit 504 executes conversion in
consideration of the characteristics of the printer and
20   adjusts the output in accordance with the density value
set by the operation unit 172.

         Then, the data is sent to a binarization unit 505.
The multilevel density data is binarized by the
binarization unit 505 so that the density value becomes
25   "0" or "255". The 8-bit image data is binarized to
1-bit image data "0" or "1", so the amount of image
data stored in the memory becomes small. However, when

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an image is binarized, the number of grayscale levels
of the image decreases from 256 to 2. For this reason,
when halftone image data such as a photographed image
is binarized, generally, the image greatly degrades.
5   To prevent this, pseudo halftoning using binary data is
necessary.

     As a pseudo halftoning technique using binary
data, an error diffusion method is used. In this
method, when the density of an image is larger than a
10   threshold value, the image is defined as density data
"255". If the density is equal to or smaller than the
threshold value, the image is defined as density data
"0". After binarization is executed in this way, the
difference between the actual density data and the
15   binary data is distributed to peripheral pixels as an
error signal. To distribute an error, an error
generated by binarization is multiplied by a weight
coefficient on a matrix prepared in advance and added
to the peripheral pixels. With this processing, the
20   average density value of the entire image is maintained,
and a pseudo-halftone image can be expressed by binary
data.

     The binarized image data is sent to the image
memory section 3 and stored. Image data input from a
25   computer or the like through the external I/F
processing section 4 is processed by the external I/F
processing section 4 as binary image data and therefore

directly sent to the image memory section 3. The image
memory section 3 has a high-speed page memory and a
large-capacity memory (hard disk) capable of storing
image data of a plurality of pages.

5   Image data of a plurality of pages stored in the
hard disk are output in accordance with an editing mode
designated by the operation unit 172 of the digital
copying machine 199. In, e.g., a sort mode, the read
image data of originals fed from the automatic document
10   feeder 6 are sequentially output. The image data of
each original, which is temporarily stored, is read out
from the hard disk. This operation is repeated a
plurality of number of times to output the image data.
With this operation, the same function as that of a
15   sorter having a plurality of bins can be realized.

      The image data output from the image memory
section 3 is sent to a smoothing unit 506 in the
printer section 2. The smoothing unit 506 interpolates
the data such that the binarized image has smooth line
20   edge portions and outputs the image data to the
exposure control section 209. The exposure control
section 209 performs the above-described processing to
form the image data on a transfer paper sheet.

      Fig. 5 is a block diagram showing the arrangement
25   of the image memory section 3. In the image memory
section 3, a page memory 301 formed from a memory such
as a DRAM is accessed to write a binary image from the

external I/F processing section 4 or image processing

unit 170, to read out an image to the printer section 2,

or input/output an image to/from a hard disk (HD) 304

serving as a large-capacity storage device through a

5   memory controller 302. Reference numeral 303 denotes

an LZ (Lempel Ziv) compression unit.

The memory controller 302 generates a DRAM

refresh signal for the page memory 301 and also

arbitrates access from the external I/F processing

10   section 4, image processing unit 170, and hard disk 304

to the page memory 301. The memory controller 302 also

controls the write address to the page memory 301, the

read address from the page memory 301, and read

direction in accordance with an instruction from the

15   CPU 171. The CPU 171 controls a function of arranging

and laying out a plurality of original images in the

page memory 301 and outputting them to the printer

section 2, a function of extracting and outputting part

of an image, or an image rotating function.

20   Fig. 6 is a block diagram showing the arrangement

of the external I/F processing section 4. As described

above, the external I/F processing section 4 loads

binary image data from the reader section 1 through the

image memory section 3 or outputs binary image data

25   from the external I/F to the printer section 2 through

the image memory section 3 to form an image. The

external I/F processing section 4 has a core section

406, a facsimile section 401, a hard disk 402 for
storing communication image data of the facsimile
section 401, a computer interface section 403 connected
to an external computer 11, a formatter 404, and an
5 image memory 405.

The facsimile section 401 is connected to a
public line through a modem (not shown) to receive
facsimile communication data from the public line and
transmit facsimile communication data to the public
10 line. To execute facsimile transmission at a
designated time or to transmit image data in accordance
with a designated password inquiry from the other party
as a facsimile function, the facsimile section 401
stores a facsimile image in the hard disk 402 and
15 processes the image data. With this arrangement, once
an image is transferred from the reader section 1 to
the facsimile section 401 or hard disk 402 for
facsimile through the image memory section 3, facsimile
transmission can be executed without using the reader
20 section 1 and image memory section 3 for the facsimile
function.

The computer interface section 403 is an
interface section for executing data communication with
the external computer 11 and has a local area network
25 (to be referred to as a LAN hereinafter), a serial I/F,
a SCSI I/F, and a centronics I/F for inputting data to
the printer. Through this I/F section, the external

computer 11 is notified of the state of the printer
section 2 or reader section 1, or an image read by the
reader section 1 is transferred to the external
computer 11 in accordance with an instruction from the
5   computer. In addition, print image data is received
from the external computer 11.

Since print data sent from the external computer
11 through the computer interface section 403 is
described in a dedicated printer code, the formatter
10   404 converts the code into raster image data for image
formation by the printer section 2 through the image
memory section 3. The formatter 404 rasterizes the
raster image data on the image memory 405.

The image memory 405 is used by the formatter 404
15   to rasterize the raster image data. Alternatively, in
sending an image read by the reader section 1 to the
external computer 11 through the computer interface
section 403 (image scanner function), the image data
sent from the image memory section 3 is temporarily
20   rasterized on the image memory 405, converted into a
data format to be sent to the external computer 11, and
sent from the computer interface section 403.

The core section 406 manages data transfer
between the facsimile section 401, computer interface
25   section 403, formatter 404, image memory 405, and image
memory section 3. Even when the external I/F
processing section 4 has a plurality of image output

sections, or even when only a single image transfer
path to the image memory section 3 is prepared,
exclusive control and priority control are executed to
output an image under the management by the core
5   section 406.

The operation of the automatic document feeder of
the present invurntion will be described next with
reference to Figs. 7A to 10B. First, the respective
sections of the automatic document feeder will be
10   described with reference to Fig. 7A.

A feed roller 601 drops on the original surface
of originals 621, including at least one sheet, placed
on an original tray 620, and rotates to feed an
uppermost original D of the originals. Before the
15   start of feeding of originals, a stopper 611 projects
as shown in Fig. 7A, so that the originals 621 are
regulated by the stopper 611 and prevented from moving
downstream.

Originals fed by the feed roller 601 are
20   separated into one sheet by the function of separation
rollers 602 and separation belt 603. This separation
is realized by a known retard separation technique.
Convey rollers 604 conveys the original separated by
the separation rollers 602 and separation belt 603 to
25   registration rollers 605 and makes the original abut
against the registration rollers 605 to form a loop,
thereby eliminating sheet skews in conveying the

original. An inverting feed flapper 613 for guiding
the original that has passed between the registration
rollers 605 to a feed path 652 serving as a convey path
to the platen 201 or an inverting inlet path 653 is
5   arranged under the registration rollers 605.

Both first inverting rollers 614 and second
inverting rollers 615 rotate to invert the original.
An inverting flapper 612 guides the original from the
direction of the second inverting rollers 615 to an
10   inverting path 650 or re-feed path 651. A belt drive
roller 606 drives a feed belt 607 for placing the
original on the platen. The feed belt 607 abuts
against the platen 201. Feed/discharge rollers 617
feed or discharge an original supplied from a manual
15   feed port 622 or discharge the original D feed by the
feed belt 607 to an original discharge port 623.

A discharge flapper 616 guides an original to a
manual feed/discharge path 654 or original discharge
path 655. In discharging an original, the discharge
20   flapper 616 acts to prevent the original from being
discharged to the manual feed port 622. A manual
feed/discharge roller 619 feeds or discharges a
manually fed original. A discharge roller 618
discharges an original. Three sensors 608, 609, and
25   610 are arranged under the original tray 620.

The original set detection sensor 610 is a
transmission-type optical sensor for detecting that the

originals 621 has been set. The original trailing-edge
detection sensor 608 is a reflection-type optical
sensor for determining whether the original is a
half-size original. The last original detection sensor
5   609 arranged between the original set detection sensor
610 and the original trailing-edge detection sensor 608
is a reflection-type optical sensor for determining
whether the original that is being conveyed is the last
original.

10   Original size detection sensors 624, 625, and 626
detect the size of the original that is being conveyed.
The three sensors are arrayed in the direction of width
of the original. The width of the original is detected
at three stages on the basis of three sensor values so
15   it can be determined whether the original is of a A
size system or a B size system, or the width of the
original such as A4 or A5 can be discriminated. Even
when the originals contains paper sheets of different
sizes, the sizes of the originals can be individually
20   detected. In this case, the originals must be placed
while aligning the "deep" edges in the original width
direction.

        The operation of the automatic document feeder in
reading both surfaces of an original (double-sided
25   original) having printed surfaces on both sides will be
described next. Referring to Figs. 7B to 8D, f
indicates the leading edge of an original, and e

indicates the trailing edge of the original.

When a double-sided original feed instruction is issued to the automatic document feeder 6, the stopper 611 moves downward, and the feed roller 601 drops onto 5 originals (Fig. 7B). Only the uppermost original is separated from the rest of originals 621 by the functions of the feed roller 601, separation rollers 602, separation belt 603, and convey rollers 604 and fed to the registration rollers 605 (Fig. 7C). At this 10 time, the inverting feed flapper 613 is set in a direction to convey the original to the inverting path 650.

When the registration rollers 605 rotate, the original is conveyed to the position shown in Fig. 8A 15 through the path shown in Fig. 7D. At this time, the drive directions of the first inverting rollers 614 and second inverting rollers 615 are reversed. The original is fed onto the platen 201 and stops at the position shown in Fig. 8B. When reading of the 20 original is ended, the original is turned through the re-feed path 651, as shown in Fig. 8C, and fed onto the platen 201 again, as shown in Fig. 8D.

When reading of the original is ended, the original is fed to the right and discharged from the 25 automatic document feeder 6 through the original discharge port 623. By repeating the above operation, the automatic document feeder 6 can separate

double-sided originals one by one from the uppermost
original, read both surfaces, and discharge the
original while facing the upper surface down.

Next, the operation of original reading scheme
5   (flow scanning) in which the scanner 202 is fixed at a
predetermined position, and an image is read while
moving an original (read-while-feed operation) will be
described for both a case wherein originals contains
only small-size originals and a case wherein originals
10   contains a large-size original. In this embodiment, a
small-size original means an original that is not
detected by the original trailing-edge detection sensor
608 when the originals 621 are placed on the original
tray 620, e.g., A4 size or letter size. A large-size
15   original means an original that is detected by the
original trailing-edge detection sensor 608 when the
originals 621 is placed on the original tray 620, e.g.,
A3 size or 11 × 17 size.

A read-while-feed operation of small-size
20   originals will be described below.

The operation until an original reaches the
registration rollers 605 is the same as that described
with reference to Figs. 7A to 7C. In the read-while-
feed operation, the original is further guided onto the
25   platen 201 by the inverting feed flapper 613, as shown
in Fig. 9A. The original is conveyed on a point A in
Fig. 9A at a predetermined speed. The image of the

original is read by the scanner 202 which is standing
by under the point A (Fig. 9B). At this time, at the
timing when the leading edge of the original passes
through the point A, a reading start signal is sent to
5   the reader section 1.

         The read original is conveyed to the right in
Fig. 9B and discharged from the automatic document
feeder 6 through the original discharge port 623
(Fig. 9C). The point A is formed from six sub-points
10   A0, A1, A2, A3, A4, and A5 in this embodiment. A
position at which the trailing edge of an original of
letter size passes through the registration rollers 605
is defined as A0, and A1, A2,... are defined in 0.5-mm
increments from the point A0 to the right. A readable
15   position determined by dust determination (to be
described later) is stored, and in the reading mode,
the scanner 202 and automatic document feeder 6 are
instructed to execute reading at the stored position.

         A read-while-feed operation of originals
20   including a large-size original or originals will be
described next. The operation until an original
reaches the registration rollers 605 is the same as
that described with reference to Figs. 7A to 7C. In
the read-while-feed operation of the originals
25   containing a large-size original or originals, the
original is further guided onto the platen 201 by the
inverting feed flapper 613, as shown in Fig. 10A. The

original is conveyed over a point B in Fig. 10A at a predetermined speed. The image of the original is read by the scanner 202 which is standing by under the point B. At this time, at the timing when the leading edge

5 of the original passes through the point B, a reading start signal is sent to the reader section 1.

The read original is conveyed to the right of the Fig. 10A and discharged from the automatic document feeder 6 through the original discharge port 623

10 (Fig. 10B). The point B is formed from six sub-points B0, B1, B2, B3, B4, and B5. A position at which the trailing edge of a 11 × 17 original passes through the registration rollers 605 is defined as B0, and B1, B2,... are defined in 0.5-mm increments from the point

15 B0 to the right. A readable position determined by dust determination (to be described later) is stored, and in the reading mode, the scanner 202 and automatic document feeder 6 are instructed to execute reading at the stored position.

20 In the stationary reading operation in which an image is read by moving the scanner 202, an original is placed at a position (position shown in Fig. 8D) at which the trailing edge of the original matches the end portion of the platen 201.

25 Fig. 11 is a view showing the direction of originals discharged from the original discharge port. Fig. 11 shows the correlation between the direction of

the originals 621 set on the original tray 620 of the automatic document feeder 6 (Fig. 7A) and the direction of the originals 621 conveyed and discharged to the original discharge port 623. The originals shown on the left side of Fig. 11 is the originals 621 set on the original tray 620. The originals are sequentially conveyed from the uppermost original 1, inverted, and output. For this reason, the discharged originals are faced down and the lowermost original on the original tray 620 is on the top of the originals, as shown on the right side of Fig. 11.

A control example when an automatic magnification function of calculating an optimum magnification factor on the basis of the original size and output paper size is set in the image reading apparatus having the above arrangement will be described.

When the automatic magnification function is set, and the originals placed on the automatic document feeder are of a single size, the first original of the bundle is fed onto the platen. The original size is detected during feeding, and the original image is read by a stationary reading operation. From the second original, the original images are read by a read-while feed operation while conveyance of originals by the automatic document feeder. However, if a read-while feed operation is impossible at that magnification factor, the original image is read by the stationary

reading operation.

When the originals placed on the automatic
document feeder contains an original or originals
having different sizes (mixed original loading mode),
5   the magnification factor must be calculated for each
original. Hence, original images are read by the
stationary reading operation until the last original.

Next, dust detection processing according to the
first embodiment of the present invention will be
10 described next. In the first embodiment, processing
for the original reading scheme (read-while-feed
operation) in which the reading position of the scanner
202 is fixed, and an image is read while moving an
original will be described.

15   Fig. 12 is a block diagram showing the
arrangement of the dust determination unit 176
according to the first embodiment of the present
invention. A plurality of originals to be read by the
reader section 1 are sequentially conveyed one by one
20 by the white feed belt 607 of the automatic document
feeder 6. An original image is read by the CCD sensor
208 (Fig. 4) of the image processing unit 170 at a
main-scanning resolution of, e.g., 600 DPI and a
sub-scanning resolution of, e.g., 600 DPI. For the
25 descriptive convenience, the resolution is set at 600
DPI in the first embodiment. However, the resolution
is not limited to 600 DPI. The output signal from the

CCD sensor 208 is converted into a digital signal by
the A/D converter 501 and subjected to shading
correction. The digital data after shading correction
is 8-bit luminance data from 0 to 255.

5   Subsequent processing varies depending on whether
the output signal from the CCD sensor 208 is a signal
for dust detection or a signal for image formation
(image data). If the signal is image data, it is input
to the log converter 502 (Fig. 4), undergoes various
10   processes at the subsequent stages, and printed by the
printer section 2. The image processing unit 170
executes image enlargement/reduction processing,
spatial filtering, luminance-density conversion,
multilevel-binary conversion, smoothing, and the like,
15   as needed.

        On the other hand, data for dust detection is
subjected to processing shown in Fig. 13. Dust
detection data to be subjected to the following
processing means data read between a given original and
20   the next original by the CCD sensor 208 (i.e., data
obtained by reading the feed belt 607).

        First, in step S10, an initial value "0" (black)
is set in the line memory 113 by the CPU 171 in advance.
In step S11, one line of the feed belt 607 is read, and
25   data representing dust or dirt is emphasized using a
one-dimensional edge emphasis filter and input to the
dust determination unit 176. In the dust determination

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unit 176, a resolution converter 111 selects data having a smaller value (black) from two adjacent pixels, thereby converting the resolution from 600 DPI to 300 DPI (step S12). The line memory 113 has a capacity for

5   one line at 300 DPI and stores 8-bit data for one pixel. In step S13, data is read out from the line memory 113 in correspondence with each pixel position of data after resolution conversion and compared with image data after resolution conversion by the comparator 112.

10 Larger data (data close to white) is selected and stored in the line memory 113 again.

With the above procedure, data of a predetermined number of lines between the originals (data of the feed belt 607) are read in accordance with a designation

15 from the CPU 171 until YES in step S14. In this case, since the position of the scanner 202, i.e., the reading position by the CCD sensor 208 is fixed, the feed belt 607 is moved by one line (step S15).

After the above processing is executed for a

20 plurality of lines (YES in step S14), of data stored in the line memory 113 in correspondence with the pixels, each data based on the feed belt 607 is replaced with white data (255) representing that no dust or dirt is present or data close to white. In contrast, dust or

25 dirt on the platen glass 201 does not move from a predetermined position and is continuously reflected on the data. For this reason, data stored in the line

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memory 113 at the address of a pixel position corresponding to dust or dirt on the platen glass 201 is data representing dust or dirt (to be referred to as "dust data"). When dust data equal to or smaller than a predetermined threshold value is extracted (step S16), the position of the dust data can be recognized (step S17).

Fig. 14A shows data in the line memory 113, which is obtained when the above-described operation is executed for 128 lines in a state wherein no dust is present on the platen glass, and the feed belt 607 is very dirty (after 60,000 or more originals are conveyed). Fig. 14B shows data in the line memory 113, which is obtained by executing the operation for 256 lines. In reading 128 lines, a plurality of pixels having a data value of 200 or less are present. In reading 256 lines, no pixel having a data value of 200 or less is present.

Fig. 15A shows data in the line memory 113, which is obtained when the above-described operation is executed for 128 lines in a state wherein the feed belt 607 has little dirt, and dust particles stick to the platen glass 201. Fig. 15B shows data in the line memory 113, which is obtained by executing the operation for 256 lines. Since the feed belt has little dirt, data of dirt of the belt is not detected. To the contrary, data values of 0, 50, and 200 can be

observed at pixels corresponding to dust particles. These values are the same for both 128-line reading and 256-line reading and are not affected by the number of read lines. For this reason, when a threshold value is determined in consideration of the degree of dirt and dust of the feed belt 607 and the number of read lines, the dirt and dust on the feed belt 607 can be accurately discriminated.

If it is determined by the above operation that dust or dirt is present on the platen glass 201, the position of the CCD sensor 208 is moved relative to the platen glass 201 (for example, the point A corresponding to the position of the scanner 202, which has been described with reference to Figs. 9A and 9B, is moved to another point in the points A0 to A5, or the point B corresponding to the position of the scanner 202, which has been described with reference to Figs. 10A and 10B, is moved to another point in the points B0 to B5), and dust detection is executed again, thereby reading an original at a position where neither dust nor dirt is present on the platen glass 201.

As described above, according to the present invention, since the average density of a white data region (feed belt) need not be obtained, unlike the prior art, the memory used to add sampling data can be omitted, and the processing time required to obtain the average density can be shortened. In addition, when

data for dust detection is converted into a low
resolution, the capacity of the line memory can be
reduced, and the circuit scale can be reduced.

<Second Embodiment>

5   The second embodiment of the present invention
will be described next. The main arrangement of a
digital copying machine serving as an image reading
apparatus according to the second embodiment is the
same as that described in the above first embodiment

10   with reference to Figs. 1 to 11, and a description
thereof will be omitted.

In the second embodiment, the arrangement and
operation of a dust determination unit 176 are
different from those of the first embodiment. The

15   arrangement and dust determination operation of the
dust determination unit according to the second
embodiment will be described below.

Fig. 16 is a block diagram showing the
arrangement of a dust determination unit 176' according

20   to the second embodiment of the present invention. The
same reference numerals as in Fig. 12 denote the same
parts in Fig. 16, and a description thereof will be
omitted. In the arrangement shown in Fig. 16, a
grayscale converter 115 is prepared in place of the

25   resolution converter 111.

In the second embodiment, processing shown in
Fig. 17 is executed for data for dust detection, i.e.,

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data obtained by reading a feed belt 607. The same step numbers as in Fig. 13 denote the like processes in Fig. 17.

First, in step S10, an initial value "0" (black) is set in a line memory 113 by a CPU 171 in advance. In step S11, one line of the feed belt 607 is read, and data representing dust or dirt is emphasized using a one-dimensional edge emphasis filter and input to the dust determination unit 176'. In the dust determination unit 176', the grayscale converter 115 re-quantizes the data into 5-bit 32-grayscale data by bit shift (step S12'). The line memory 113 has a capacity for one line and stores 5-bit data for one pixel. In step S13', data is read out from the line memory 113 in correspondence with each pixel position of data after grayscale conversion and compared with image data after grayscale conversion by a comparator 112. Larger data (data close to white) is selected and stored in the line memory 113 again.

With the above procedure, data of a predetermined number of lines between the originals (data of the feed belt 607) are read in accordance with a designation from the CPU 171 until YES in step S14. As in the first embodiment, since the position of a scanner 202, i.e., the reading position by a CCD sensor 208 is fixed, the feed belt 607 is moved by one line (step S15).

After the above processing is executed for a

plurality of lines (YES in step S14), of data stored in
the line memory 113 in correspondence with the pixels,
each data based on the feed belt 607 is replaced with
white data (255) representing that no dust or dirt is
5   present or data close to white. In contrast, dust or
dirt on the platen glass 201 does not move from a
predetermined position and is continuously reflected on
the data. For this reason, data stored in the line
memory 113 at the address of a pixel position
10   corresponding to dust or dirt on the platen glass 201
is data representing dust or dirt (to be referred to as
"dust data"). When dust data equal to or smaller than
a predetermined threshold value is extracted (step S16),
the position of the dust data can be recognized (step
15   S17).

        Fig. 18A shows data in the line memory 113, which
is obtained when the above-described operation is
executed for 128 lines in a state wherein no dust is
present on the platen glass, and the feed belt 607 is
20   very dirty (after 60,000 or more originals are
conveyed). Fig. 18B shows data in the line memory 113,
which is obtained by executing the operation for 256
lines. In reading 128 lines, a plurality of pixels
having a data value of 25 or less are present. In
25   reading 256 lines, no pixel having a data value of 25
or less is present.

        Fig. 19A shows data in the line memory 113, which

is obtained when the above-described operation is executed for 128 lines in a state wherein the feed belt 607 has little dirt, and dust particles stick to the platen glass 201. Fig. 19B shows data in the line memory 113, which is obtained by executing the operation for 256 lines. Since the feed belt has little dirt, data of dirt of the belt is not detected. To the contrary, data values of about 0 and 20 can be observed at pixels corresponding to dust particles. These values are the same for both 128-line reading and 256-line reading and are not affected by the number of read lines. For this reason, when a threshold value is determined in consideration of the degree of dirt and dust of the feed belt 607 and the number of read lines, the dirt and dust on the feed belt 607 can be accurately discriminated.

If it is determined by the above operation that dust or dirt is present on the platen glass 201, as in the first embodiment, the position of the CCD sensor 208 is moved relative to the platen glass 201, and dust detection is executed again, thereby reading an original at a position where no dust or dirt is present.

According to the second embodiment, the same effect as in the first embodiment can be obtained.

<Modification>

In the first and second embodiments, when dust or dirt on the platen glass 201 is detected, the position

of the CCD sensor 208 is moved to prevent the dust or
dirt from being read. However, a dust component may be
erased from image data. Figs. 20 and 21 are block
diagrams showing the arrangements of a dust

5 determination unit 176 or 176' and an image processing
unit 170' when a dust component is to be erased from
image data. Fig. 22 is a flow chart showing a
procedure of image processing in the modification. The
image processing unit 170' has a data replacement unit

10 114 in addition to the arrangement shown in Fig. 4.

First, a dust detection result is prepared in the
line memory 113 in accordance with the same procedure
as in the first or second embodiment described with
reference to Fig. 13 or 17. Next, a threshold value

15 used to determine dust or dirt is set in the comparator
112 by the CPU 171. This set value is determined on
the basis of the state of the feed belt 607 and the
number of reference lines. The comparator 112 compares
each data stored in the line memory 113 with the

20 threshold value to detect dust data and dust position
(step S21) and transfers the detected dust position to
the data replacement unit 114.

For the image data obtained by reading the
effective data region of an original image by the CCD

25 sensor 208 (step S22), the data replacement unit 114
determines for each pixel whether the image data
corresponds to the dust position (step S23).

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If YES in step S23, the image data is replaced with image data input at the immediately preceding pixel in step S24. This operation is executed for all image data, thereby erasing the dust component.

5   If no dust or dirt can be detected by the comparator 112, the entire processing by the data replacement unit 114 may be omitted.

In the above example, image data corresponding to a dust position is replaced with image data input at
10   the immediately preceding pixel. However, the present invention is not limited to this. The image data may be replaced using a known interpolation method on the basis of image data of an adjacent pixel.

<Third Embodiment>

15   The third embodiment of the present invention will be described next. The arrangement of a digital copying machine serving as an image reading apparatus according to the third embodiment is the same as that described in the above first embodiment with reference
20   to Figs. 1 to 11, and a description thereof will be omitted.

In the third embodiment, the arrangement and operation of a dust determination unit 176 are different from those of the first and second
25   embodiments. The arrangement and dust determination operation of the dust determination unit 176 according to the third embodiment will be described below.

The dust determination unit 176 according to the
third embodiment comprises a dirt level adding unit 701,
dust detection level setting unit 702, and dust
detection unit 703, as shown in Fig. 23. The dirt
5   level adding unit 701 reads an image on the surface of
an original convey section for sequentially conveying a
plurality of originals onto the platen. The dust
detection level setting unit 702 sets a dust detection
level on the basis of the sum result from the dirt
10   level adding unit 701. The dust detection unit 703
compares an image signal obtained from a CCD sensor 208
with the set dust detection level to determine whether
the image data of a dust component is contained in the
read image data.

15   An image of a feed belt 607 formed on the CCD
sensor 208 through a lens 207 is read and digitized,
like an image obtained by reading an original, and
subjected to shading correction. Data for dust
detection is sent to the dust determination unit 176.

20   In the dust determination unit 176, input data for dust
detection is added with the previously obtained data
for each pixel. If the sum result is less than a
predetermined level, it is determined that a dust
particle sticks to the pixel portion.

25   Fig. 24 is a flow chart showing the basic
operation related to the dust detection operation.

First, the current position at which a read-

while-feed operation is performed (i.e., the fixed
reading position of a scanner 202) is set (step S101).
In dust detection in the read-while-feed operation, an
image is read while moving a feed belt 607 of an
5   automatic document feeder 6 without feeding any
original whereby dust and/or dirt on a platen glass 201
is detected. When the surface of the feed belt 607 of
the automatic document feeder 6 is dirty, dirt on the
platen glass 201 cannot be properly detected. For this
10   reason, the dirt level of the feed belt 607 of the
automatic document feeder 6 is detected before dust
detection (step S102).

      Dirt level detection for the feed belt 607 is
done by reading an image from the CCD sensor 208
15   without feeding any original and adding image data of
the surface of the feed belt 607 in an image memory
(not shown) in the dirt level adding unit 701. The
contents of the image memory are searched to detect a
region that is supposed to be dirt on the belt because
20   the image reading level is low. The reading level of
the region is stored.

      Using the dirt level of the surface of the feed
belt 607 of the automatic document feeder 6 as a
reference, the dust detection level is set (step S103).
25   In the third embodiment, the dust detection level
setting unit 702 sets in the dust detection unit 703 as
a dust detection level a value obtained by subtracting

a predetermined value from the sum value of reading levels obtained by reading the image of the surface of the feed belt 607.

Under this control, if the surface of the feed belt 607 is dirty, the dust detection level is set to be low to make it hard to detect dust. With this processing, detection error that dirt on the surface of the feed belt 607 is detected as dust or dirt on the surface of the platen glass 201 can be prevented. If the surface of the feed belt 607 is clean without any dirt, the dust detection level is set to be high to make it easy to detect dust. With this processing, dust or dirt on the surface of the platen glass 201 can be accurately detected.

When the dirt level exceeds a predetermined level, i.e., when, in detecting the dirt level, dust or dirt already sticks to the platen glass 201, the dirt level of the surface of the feed belt 607 cannot be properly detected. For this reason, if the dirt level obtained by reading the image of the surface of the feed belt 607 exceeds a predetermined level, a general design value is set as the dust detection level instead of setting the dust detection level on the basis of the dirt level.

When the read-while-feed operation of reading an image of an original being conveyed by the document feeder 6 is to be executed, a time when no image

reading operation is executed is used. Without
changing the current position for the read-while-feed
operation, the feed belt 607 is moved without feeding
any original, and the image is read. As the read image
5 signal, the image of the surface of the feed belt 607
of the document feeder is input. However, when dust
sticks to the platen glass 201, an image continuous in
the sub-scanning direction is detected in the read
image signal.

10   If such an image probably based on dust or dirt
on the platen glass 201 is detected after the feed belt
607 is driven for a predetermined time to read the
image (YES in step S105), it is determined that the
read-while-feed operation cannot be continued at the
15 same reading position. If no abnormal image is
detected (NO in step S105), it is determined that the
read-while-feed operation is to be continued at that
position, and the processing is ended. The
presence/absence of dust is determined by comparison
20 with the dust detection level set in the dust detection
unit 703 (step S104). If an image darker than the dust
detection level is detected, it is determined that dust
sticks to the platen glass 201. If an image brighter
than the dust detection level is detected, it is
25 determined that dirt of the belt is read, and no dust
or dirt sticks to the platen glass.

       When dust or dirt of the platen glass 201 is

detected at the current position for the read-while-
feed operation (YES in step S105), the position is
moved to a predetermined position to detect a position
where the read-while-feed operation is possible. The
5   scanner 202 is moved from that position in a
predetermined direction by a predetermined distance,
thereby sequentially searching for a position where the
read-while-feed operation is possible. For example,
when the position for the read-while-feed operation is
10   the point A described with reference to Figs. 9A to 9C,
the scanner 202 is moved leftward to the point A0.
After that, the scanner 202 is moved from the point A0
to A1, A2,... to search for a position where flow
scanning is possible.

15   First, the scanning position is moved to a
predetermined position (step S106), and that position
is defined as the next candidate position (i) where the
read-while-feed operation can be performed. It is
determined in step S107 whether the current position
20   for the read-while-feed operation falls outside a
predetermined range. For example, when the flow
scanning position is the point A described with
reference to Figs. 9A to 9C, it is determined whether
the flow scanning position falls outside the range of
25   the points A0 to A5. A rightmost position MAXi in step
S107 is A5. If YES in step S107, the flow advances to
step S111. If NO in step S107, since the flow scanning

position falls within the predetermined range, the flow advances to step S108.

In step S108, to detect whether the read-while-feed operation can be executed at that position (whether dust is present), the above-described image reading operation for dust detection (move feed belt without feeding any original, read image, and analyze image) is performed. If it is determined that no dust or dirt is present (NO in step S109), it is determined that the read-while-feed operation is possible at that position (step S112), and the next read-while-feed operation is executed at that position. If dust or dirt is detected by the detection operation (YES in step S109), the position is moved by a predetermined distance in the sub-scanning direction (step S110), and processes in steps S107 to S109 are repeated. This processes are repeated until a position where the read-while-feed operation can be executed is found or the moved position falls outside of the predetermined range.

When dust or dirt is detected at all of the predetermined number of reading positions by dust detection (YES in step S107), it is determined that image reading by the read-while-feed operation cannot be executed, and the copying machine is set in a dust-presence state (step S111). Until it is determined by predetermined processing (to be described later) that the read-while-feed operation is possible,

the reading operation by the read-while-feed operation
is not performed.

A control example when it is determined whether
flow scanning is to be executed on the basis of the
result of dust detection operation using a read-while-
feed inhibition flag, and the user is notified of the
presence of dust or dirt in the image reading apparatus
having the above arrangement will be described.

Fig. 25 is a flow chart showing the control
method. This control starts when no dust-presence
message is displayed, originals are set, and a mode in
which reading is executed by the read-while-feed
operation is set.

First, in step S201, it is determined whether the
read-while-feed inhibition flag is set. If NO in step
S201, the read-while-feed operation can be executed.
Hence, the flow advances to step S202 to move the
scanner to a point that is stored as a reading position.
Thereafter, the flow advances to step S203 to feed the
uppermost original, and reading processing by the read-
while-feed operation is executed. The flow advances to
step S204 to determine whether the fed original is the
last original, and the reading processing is ended. If
NO in step S204, the flow returns to step S203 to
continue the reading processing.

If YES in step S204, the flow advances to step
S205 to execute the dust detection operation shown in

Fig. 24. The flow advances to step S206 to determine
whether all points have dust or dirt as a result of
dust detection in step S205. If any one of the points
has no dust or dirt, the flow advances to step S207 to
5   store the point without any dust or dirt as the
position to be subsequently used in the read-while-feed
operation. Then, the flow advances to step S208 to
move the scanner 202 to a predetermined standby
position, and the processing is ended.

10   If it is determined in step S206 that all the
positions have dust, the flow advances to step S209 to
set the read-while-feed inhibition flag. Then, the
flow advances to step S210 to notify a message as shown
in Fig. 27 by display or sound to prompt the user to
15   clean the dust and/or dirt, and the flow advances to
step S208.

     If YES in step S201, it means that the message is
cleared without cleaning the dust and/or dirt. Hence,
the original cannot be properly read in the read-while-
20   feed operation. Hence, the reading method is switched
to stationary reading operation capable of reading the
original with less influence of dust and/or dirt. The
flow advances to step S211 to execute reading
processing in the stationary reading operation. Then,
25   the flow advances to step S212 to determine whether the
fed original is the last original and the reading
processing is ended.

If NO in step S212, the flow returns to step S211 to continue the reading processing. If YES in step S212, the flow advances to step S213 to notify the message as shown in Fig. 27 by display and/or sound to prompt the user to clean the dust. After that, the processing is ended. A control example when a message is to be displayed when the read-while-feed inhibition flag is set after the end of the reading operation has been described above.

Fig. 26 is a flow chart showing a control example when the processing in Fig. 25 is ended while keeping the dust-presence message displayed. Fig. 26 shows a control method of clearing the message by user's key input. This control starts when the dust-presence message is displayed after the end of the reading operation.

First, it is determined in step S301 whether the clean key is input. If NO in step S301, the flow advances to step S302 to determine whether the OK key is input. If NO in step S302, the flow returns to step S301 to repeat the above processing.

If YES in step S301, it is determined that cleaning has been done. The flow advances to step S306 to clear the read-while-feed inhibition flag. After that, the flow advances to step S307 to clear the message, and the processing is ended.

If YES in step S302, it is determined that

cleaning is not executed. The flow advances to step
S307 to clear the message without clearing the read-
while-feed inhibition flag, and the processing is ended.
For the next reading, the reading mode can be re-set.
5   When the reading operation is performed, the message is
displayed again after the end of reading, as described
with reference to Fig. 25.

With the above-described control, after the end
of the reading operation by a read-while-feed operation,
10   dust detection can be performed. In addition, if it is
determined on the basis of the dust detection result
that the flow scanning operation cannot be executed at
any position, an alarm window as shown in Fig. 27 is
displayed to set an alarm state, thereby preventing
15   subsequent user operation from being continued.

As described above, according to the third
embodiment, dirt on the surface of the conveyor belt is
read, and the dust detection level is adjusted in
accordance with the dirt level. With this processing,
20   the influence of dust or dirt on the platen glass can
be eliminated while ensuring a high original reading
speed for the read-while-feed operation independent of
the dirt on the conveyor belt surface. This prevents
wasteful operation of re-executing original reading
25   when the dust or dirt is read together with the
original image, and improves the productivity of
reading operation.

In the first to third embodiments, the flow scanning position is set at a position corresponding to the feed belt. However, the present invention is not limited to this, and any other position can be set as long as a read-while-feed operation can be executed at that position. For, e.g., a document feeder which does not use a feed belt but a feed roller, the present invention can be applied by setting the flow scanning position near a point where the feed roller abuts against the platen glass and reading the feed roller instead of the feed belt in dust detection.

<Other Embodiment>

The present invention can be applied to a system constituted by a plurality of devices (e.g., host computer, interface, reader, printer) or to an apparatus comprising a single device (e.g., copying machine, facsimile machine).

Further, the object of the present invention can also be achieved by providing a storage medium storing program codes for performing the aforesaid processes to a computer system or apparatus (e.g., a personal computer), reading the program codes, by a CPU or MPU of the computer system or apparatus, from the storage medium, then executing the program.

In this case, the program codes read from the storage medium realize the functions according to the embodiments, and the storage medium storing the program

codes constitutes the invention.

Further, the storage medium, such as a floppy
disk, a hard disk, an optical disk, a magneto-optical
disk, CD-ROM, CD-R, a magnetic tape, a non-volatile
5   type memory card, and ROM can be used for providing the
program codes.

Furthermore, besides aforesaid functions
according to the above embodiments are realized by
executing the program codes which are read by a
10   computer, the present invention includes a case where
an OS (operating system) or the like working on the
computer performs a part or entire processes in
accordance with designations of the program codes and
realizes functions according to the above embodiments.

15   Furthermore, the present invention also includes
a case where, after the program codes read from the
storage medium are written in a function expansion card
which is inserted into the computer or in a memory
provided in a function expansion unit which is
20   connected to the computer, CPU or the like contained in
the function expansion card or unit performs a part or
entire process in accordance with designations of the
program codes and realizes functions of the above
embodiments.

25   In a case where the present invention is applied
to the aforesaid storage medium, the storage medium
stores program codes corresponding to the flowcharts

shown in Figs. 13 or 17 and/or 22 or 24, 25 and 26 described in the embodiments.

Further, the present invention includes combinations of the aforesaid embodiments or technical elements disclosed therein.

The present invention is not limited to the above embodiments and various changes and modifications can be made within the spirit and scope of the present invention. Therefore to apprise the public of the scope of the present invention, the following claims are made.